SSE – ED1 CABLE REPLACEMENT

CARRADALE-ARRAN

Project Description – Carradale - Arran

GO Reference : 3234-GO-O-TB-0001

REVISION	DATE	ISSUE DETAILS	PREPARED	CHECKED	APPROVED
01	08-02-21	Issued for Review	MW	SW	CC
02	15-02-21	Issued for Review	MW	SW	CC
03	25-05-21	Issued for Review	MW	SW	CC
04	28-05-21	Final Client review	RB (SSEN)	SSEN	SSEN
05	17-06-21	Additional Information	RB (SSEN)	SSEN	SSEN
06	21-06-21	Issued to SSEN for Information	MW	GW	CC

REVISION	SECTION	PAGES	BRIEF DESCRIPTION OF CHANGES	AUTHOR/S OF CHANGE
05	6.4.6.1 5.1		Additional information on clump weight moorings inserted. Concrete mattress allowance inserted.	RB (SSEN)
06	6.3		Additional Information added on Sea Earthing. New Section 6.3.	MW

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Abbreviation and Definitions

The table below show a list of abbreviations and definitions used in this document:

List of Abbreviations and Definitions

Abbreviation	Definition
A/C	Alter Course
ADCP	Acoustic Doppler Current Profiler
AHC	Active Heave Compensation
AToN	Aid to Navigation
AWAC	Acoustic Wave and Current profiler
CBRA	Cable Burial Risk Assessment
C/L	Centreline
CLV	Cable Lay Vessel
CPSP	Cable Protection and Stabilisation Plan
CPT	Cone Penetration Test
CR	Client Representative
DGPS	Differential Global Positioning System
DP	Dynamic Positioning
DWA	Double Wire Armoured
FAT	Factory Acceptance Test
FLMAP	Fishing Liaison Mitigation Action Plan
FO	Fibre Optic
FOC	Fibre Optic Cable
GB	Gigabyte
GMG	Global Marine Group
GMSL	Global Marine Systems Ltd.
GPS	Global Positioning System
HDD	Horizontal Directional Drilled
HDPE	High Density Poly Ethylene
HP	Horse Power
HV	High Voltage
HVAC	High Voltage Alternating Current
ID	Inner Diameter
ISM	International Safety Management
ISO	International Organization for Standardization
km	kilometre
kN	Kilo Newton
KP	Kilometre Point

kV	Kilo Volt
LAT	Lowest Astronomical Tide
LGP	Low Ground Pressure
LP	Landing Point
MBES	Multi-Beam Echosounder
MBR	Minimum Bend Radius
MCA	Maritime Coastguard Agency
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
msw	Meters Sea Water
nm	Nautical Mile
NTM	Notice to Mariners
OBS	On-Bottom Stability
OCMA	Oil Company Materials Association
OD	Outer Diameter
OHSAS	Occupational Health and Safety Assessment Series
OOS	Out or Service
OTDR	Optical Time Domain Reflectometer
PE	Poly-ethylene
PLGR	Pre-lay Grapnel Run
RB	Rock Bag
RHIB	Rigid Hulled Inflatable Boat
ROV	Remote Operated Vehicle
RPL	Route Position List
SDR	Standard Dimension Ratio
SHEPD	Scottish Hydro Electric Power Distributions
SIMOPS	Simultaneous Operations
SOLAS	Safety of Life at Sea
SSEN	Scottish and Southern Electricity Networks (SSE plc)
TDR	Time Domain Reflectometer
TJP	Transition Joint Pit / Terminal Junction Pit
TMS	Tether Management System
UAV	Unmanned Air Vehicle
UDL	Uniformly Distributed Load
UXO	Unexploded Ordnance
WD	Water Depth

1.0 Introduction and Background

1.1 Introduction

Scottish Hydro Electric Power Distribution (SHEPD) has contracted Global Marine Group to install a replacement 33kV circuit between Carradale and Arran. Figure 1 outlines the location of the route in red.

Figure 1: Route Overview

There are currently two circuits connecting the Mull of Kintyre at Carradale with the Isle of Arran. Both connections currently operate at 33kV. The northern cable has been identified for replacement from asset integrity inspections. The replacement of this cable is essential to securing SHEPD power supplies to Arran.

SHEPD previously appointed a Contractor to conduct marine surveys along the proposed cable route in 2018. These surveys encompassed a corridor ranging from 1444m wide at Kintyre to 980m at Arran. Further route surveys have been undertaken in late 2020/ early 2021 in order to inform the final design and consenting process.

Consent for the cable installation operations is now being sought based on a 500m corridor centred on the proposed RPL. Figure 2 shows the planned route in yellow with the 500m buffer around it.

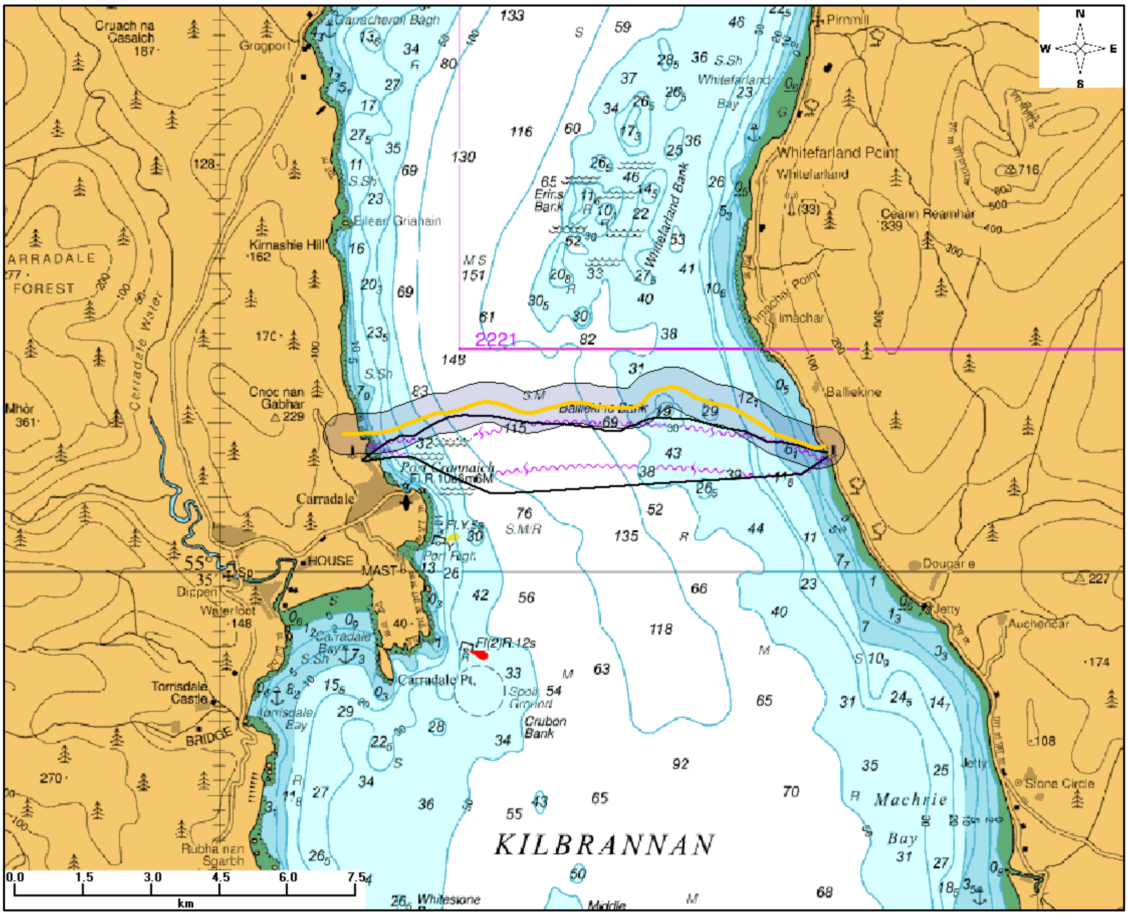


Figure 2: Carradale Arran Existing Routes

1.2 Overview of Scope of Work

Global Marine Group's (GMG's) scope of work for the Cable Replacement Includes:

- Pre-Installation Surveys
- Landfall establishment
- 2 x horizontal directional drill (HDD) installation at Carradale (1x operational & 1x spare)
- Subsea Cable Installation
- Cable Protection and Post-Installation Surveys
- Landfall re-instatement

1.3 Project Key Dates

The below Table 1: Carradale-Arran Operation Durations provides an indicative schedule of durations for the above works and may be subject to change:

Carradale-Arran – Task Durations	
Onshore Works	94 days
Offshore Works	52 days
Nearshore Works	18 days
Cable Pull-In	5 days
Re-instatement	8 days

Table 1: Carradale-Arran Operation Durations

2.0 Pre-Installation Survey Works

Pre-Installation Survey works were undertaken from December 2020 to Feb 2021 and were split into Offshore and Land based.

2.1 Offshore

The following were conducted as part of the offshore surveys:

- Unexploded Ordnance (UXO) Survey
- Geophysical (Arran ONLY)
- Geotechnical Survey
- Environmental Survey

The Surveys required that the following equipment be mobilised:

Equipment used for Offshore Survey	
Side scan sonar	Vibro Corer (3m)
Sub-bottom profiler (Innomar)	Grab Sampler
Multibeam echosounder	CPT Rig (3m)
Magnetometers	Subsea Cameras

Table 2: Equipment used in Offshore Survey

The offshore UXO survey vessel investigated a 50m wide (+/- 25m of the Route Position List (RPL) C/L) survey corridor up to 15m LAT.

The inshore vessel(s) investigated a 500m wide geophysical survey (+/- 250m of the RPL C/L) survey corridor in areas which couldn't be covered by the offshore vessel due to shallow water depths. The extent inshore was the safe operating depth of the vessel. The extent offshore was 250m beyond the 15m LAT contour.

Geotechnical sampling was conducted at areas of interest identified from the geophysical survey.

The Environmental Survey required an environmental specialist review and assess the results of the geophysical data acquired as part of the associated cable Route Survey. Any locations identified as a result of this review as having the potential for the presence of habitats of conservation interest were then selected for further drop-down video/stills survey points.

2.2 Land Based

- Topographic
- UXO (Arran ONLY)
- Geotechnical (Arran ONLY)
- Environmental (Intertidal) (Arran ONLY)

A topographical survey was undertaken at all the landing sites. The corridor was defined as being +/- 125m from the proposed centre line and runs from MLWS to 200m behind the Terminal Junction Pit (TJP) which lies above MHWS.

Geotechnical sampling was also undertaken and depicted on the longitudinal profile. This took the form of penetration tests to refusal using an auger. Samples were taken at 25 m intervals along the profile. Each sample was taken to 2.5m depth or refusal and was backfilled.

A 50m wide UXO survey (+/- 25m of the RPL C/L) was undertaken to complete the coverage from the closest approach of the nearshore vessel to 50m beyond the TJP. This survey conducted using a drone (Unmanned Air Vehicle (UAV)) solution and suspended magnetometers.

A shore/intertidal survey was conducted at low water springs (or as close as possible). The survey was conducted by a shore walk with Global Positioning System (GPS) and base maps; the main intertidal habitat was inventoried and mapped during the survey. Photographs were collected of representative quadrats.

2.3 Environmental data gathering

In addition to the Offshore and Land based surveys described above, environmental data was gathered using an Acoustic Doppler Current Profiler (ADCP).

One ADCP was deployed along the Carradale-Arran route for a minimum of 28 days in order to gather current and wave data for the site. This data was used to inform on-bottom stability assessment for the cable and therefore allow a further detailed engineering assessment of the cable protection methods and quantities required along the route.

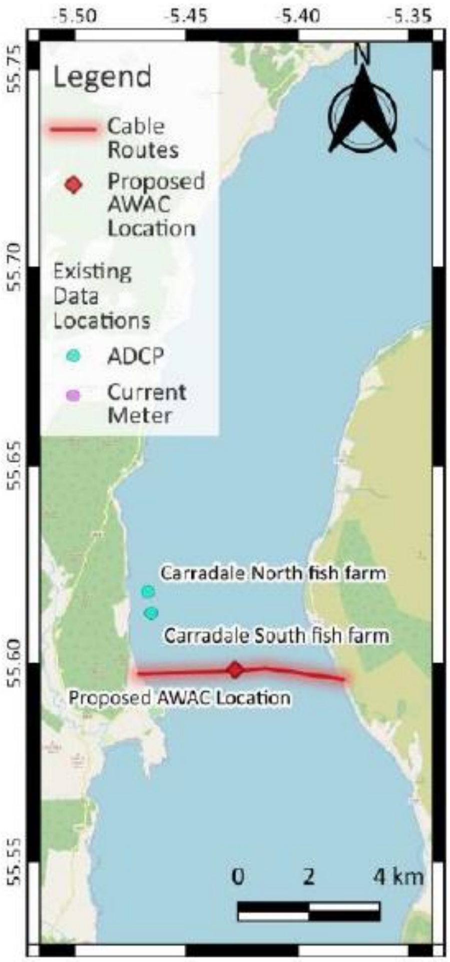


Figure 3: ADCP Deployment Location - Carradale-Arran

Figure 4: Example of ADCP deployed inside protection frame

3.0 Cable Information and Load Out

3.1 Cable Construction

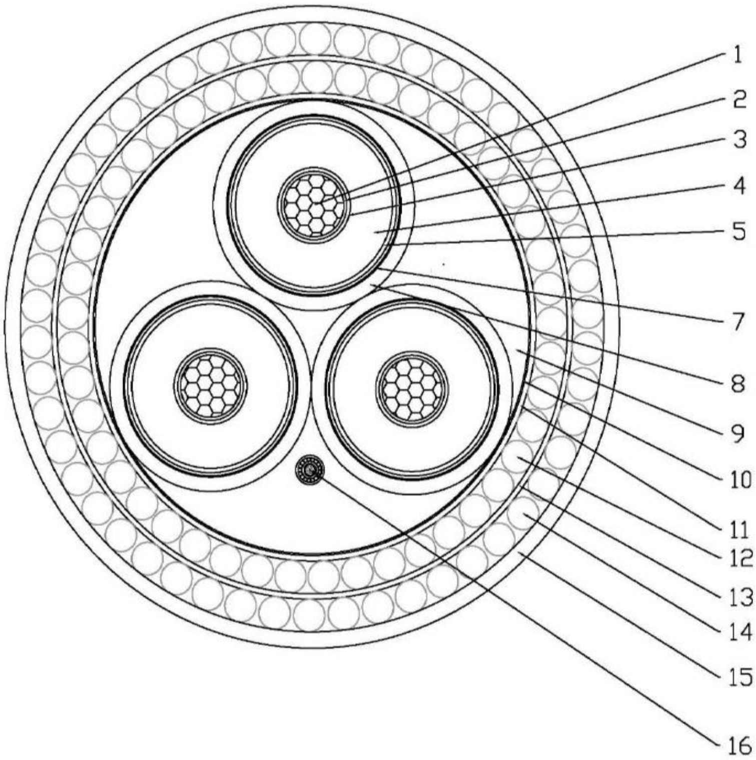
The cable to be installed will be a High Voltage Alternating Current (HVAC) submarine cable.

SHEPD will free-issue the cable conforming to the requirements in Table 3: Cable Specification.

TYPE	LENGTH (km)	DIAMETER (mm)	MBR (m)	Cable weight in air (kg/m)
3x185mm2 Cu DWA 36kV	7.0	132.4	2.0m (installation)	39.3

Table 3: Cable Specification

A cross section of the cable is provided in Figure 5: Cross Section Profile of 185mm2 Cu DWA 36kV below:



1 - Copper round stranded compacted class 2 according to BS EN 60228 of nominal cross-section equal to 185 sq.mm, longitudinally water sealed.

2 - Semi-conductive waterblocking tape applied helically with overlap.

3 - Conductor non-metallic extruded screen: Extruded semiconducting compound bonded to inner surface of insulation.

4 - Insulation: cross-linked polyethylene (XLPE) water-tree retardant type GP8 according to BS 6622 of 8.0 mm nominal thickness. 1,2

5 - Core non-metallic extruded screen: Extruded semiconducting compound firmly bonded to the insulation.

6 - Semi-conductive waterblocking tape applied with overlap.

7 - Metallic screen and radial watertightness: CU/PE laminated tape of 0.2 mm nominal thickness bonded to oversheath, longitudinally applied with overlap.

8 - Sheath: High Density Polyethylene (HDPE) of 2.5 mm approximate thickness. Sheath colour: Black.

9 - Non-hygroscopic fillers at the interstices between cores in order to give the cable a circular cross-section.

10 - Binding tape helically applied with overlap.

11 - One layer of polypropylene yarns of approximate thickness of 1 mm.

12 - Inner layer of armour consisting of one layer of helically applied bitumen compound coated galvanized round steel wires of grade 34. class A. 6.0 mm nominal diameter according to EN 10257-2

13 – Separator layer consisting of a single layer of polypropylene yarns of 1 mm approximate thickness.

14 - Outer layer of armour consisting of one layer of helically applied bitumen compound coated galvanized round steel wires of grade 34. class A. 6.0 mm nominal diameter according to EN 10257-2

15 - Two layers of polypropylene yarns with total approximate thickness of 3 mm. Over the inner (first) layer bitumen is applied. Also, the outer (second) layer shall consist of black and yellow polypropylene yarns as to form a helical yellow stripe.

16 - Armoured Optical unit of 16 mm approximate diameter each one consists of a stainless-steel tube (containing 48 optical single mode fibres), PE inner sheath, galvanized steel wire armour and PE oversheath.

Figure 5: Cross Section Profile of 185mm2 Cu DWA 36kV

4.0 Vessel and Equipment Specifications

Global Marine operates a fleet of vessels that are regulated under The International Convention for the Safety of Life at Sea (SOLAS) and which are all required to comply with the International Safety Management (ISM) Code. Global Marine's Safety Management System ensures compliance with mandatory fleet rules and regulations and that applicable codes, guidelines and standards recommended by Administrations, Classification Societies and maritime industry organisations are met appropriately.

During the immediate lead-up to the project Global Marine will issue the Notice to Mariners and complete updates to the Kingfisher Fortnightly Bulletin.

4.1 Cable Lay Vessel (CLV)

The Global Symphony or a similar vessel will be the main Cable Lay Vessel (CLV) of this project.

The Global Symphony is a purpose-built Installation / Remote Operating Vehicle (ROV) support vessel specifically designed for deep water Remote Intervention, Construction, Trenching & Survey.

Figure 6: Global Symphony

The vessel is equipped with a McGregor Hydramarine "Active Boost" 150T AHC knuckle-boom crane capable of subsea lifts at 150Te in single fall mode down to 3,000m as well as two FCV3000 Work Class ROVs located within ROV garages of the vessel superstructure.

ITEM	DESCRIPTION
Type	DP Class 2
Gross Tonnage	11,324te
Dimension – Length (a/o)	130.2m
Dimension – Beam	24m
Draft	7.5m
PoB (Max.)	105

Table 4: Global Symphony Characteristics

Figure 7: Global Symphony Back Deck

4.2 FCV3000 Work Class ROV

The FCV3000 is a 3000msw rated modern work class ROV which can carry a wide range of survey equipment. The ROV is deployed with a Top Hat tether management system (TMS) fitted with 600m of umbilical.

The ROV will be used for Touch Down Monitoring (TDM) throughout cable lay operations and HDD pull-in as well as any subsea intervention works and post lay survey.

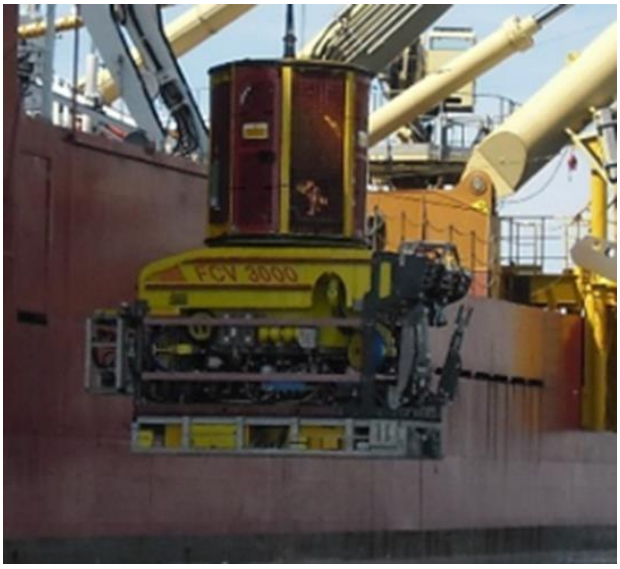


Figure 8: FCV3000 Deployment

ITEM	DESCRIPTION
Type	FCV3000 (150HP)

Length	3.3m
Height	1.7m (exc. TMS)
Width	1.7m (exc. TMS)
Weight	4.1te (inc. 400kg payload)

Table 5: FCV3000 Specifications

4.3 Cable Protection and Stabilisation Installation Vessel

Upon completion of the cable installation campaign, it is possible that there will be a requirement to install some protection. Cable protection and stabilisation may include a combination of concrete mattresses, rock bags and rock placement. Details of these methods are described in Section 5.1 and Section 6.5.6 below. The final quantity of protection and stabilisation to install will dictate the type of vessel that may be used.

It is likely that the bulk of the installation will take place from a DP Class 2 vessel. Specifications of this vessel would be comparable to that of the Global Symphony as described in Section 4.1 above.

For locations where a DP Class 2 vessel cannot access due to water depth restrictions, a Multicat vessel would be used. Details of such a vessel can be found in Section 4.13 below.

4.4 Rock Placement Vessel

In areas where there could be sections of unprotected surface laid cable it may be necessary to employ rock placement as cable protection. In such cases a rock placement campaign may be considered using a DP2 vessel.

The below vessel is an example of a Fall Pipe Vessel that could be used.

Figure 9: FPV Flintstone

ITEM	DESCRIPTION
Type	DP Class 2
Gross Tonnage	21,710te
Dimension – Length (a/o)	154.6m
Dimension – Beam	32.2m
Draft (fully loaded)	7.74m

Table 6: FPV Specifications

The above example vessel is capable of accurately placing rock in water depths of up to 2000m. The FPV carries rock within its high capacity hoppers and can place this on the seabed in order to protect cable from subsea activity. The Fall pipe is manoeuvred like an ROV and can utilise cable position tracking systems to ensure that the rock placement is undertaken accurately.

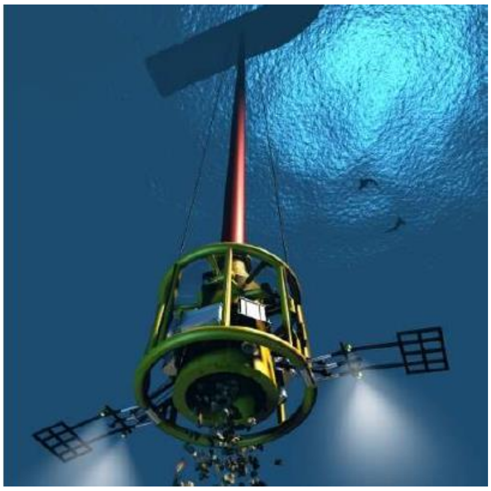


Figure 10: Fall Pipe

4.5 Onshore installation and Excavation

The excavation works at the TJP will be carried out with the aid of a 13Te LGP tracked excavator. At the Arran landfall the cable route is proposed to be excavated between the TJP and the shore.

Figure 11: Example 13te LGP Excavator

4.6 Tracked Winch

Pull-Ins will be performed using a tracked 10Te constant tension capstan winch which has an electronic cable recording device which can be downloaded as evidence of the cable pull tensions. The winch will self-track into place to ensure the allowable over pull is considered. The winch will be anchored back using certified anchor chains and pinned anchor blocks.

Figure 12: Tracked 10Te Bull Wheel Winch

4.7 250te HDD Drill Rig

At the Carradale landfall a 250te Drill Rig will be used to drill the two HDD bores for the ducts to be pulled into. The rig typically comprises 15 articulated vehicle loads plus a 100-tonne mobile crane and supporting loads of water and drilling chemicals

Figure 13: 250te Drill Rig

ITEM	DESCRIPTION
Type	250te
Dimensions	15 x 2.5mx 3.6m
Weight	32te
Max Pull Force	250te
Max Push Force	100te
Entry angle	8º – 45º
Length Drilling Rods	9m
Required Working Site -ENTRY	2400m^2
Required Working Site -EXIT	200m^2

Table 7: Drill Rig Specifications

4.8 Quadrant and Beach Rollers

At the Arran landfall various cable quadrants will be used on the beach along with pipe cradle lifters to handle the cable to shore and into the excavated trench.

Figure 14: Example of the Beach Quadrant Layout during pull-in

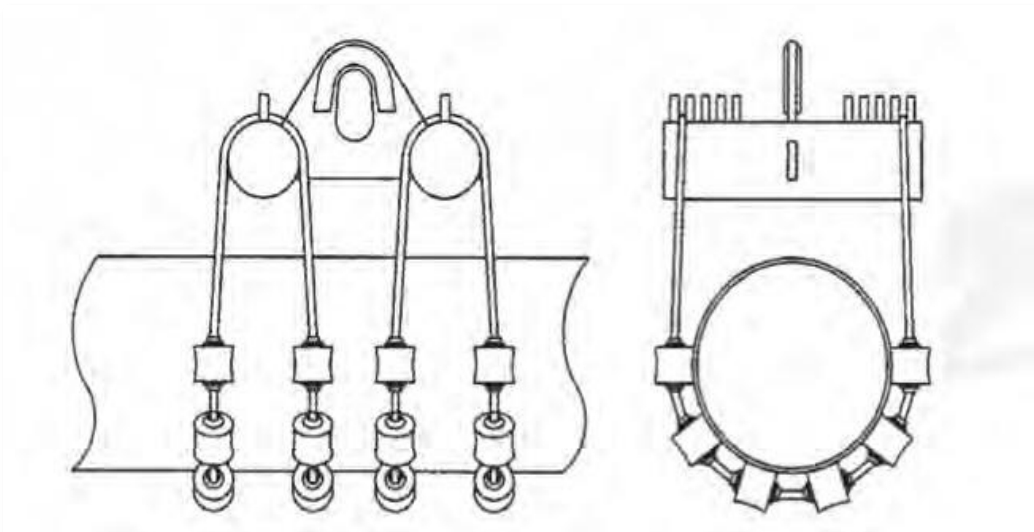


Figure 15: Pipe Cradle Lifter

4.9 Cable Bollard

A survey team will accurately mark out the onshore cable pull-in route and positions of the cable handling equipment such as bollards, excavator, rollers, quadrants and skid steer winch.

The Bollard Roller shall be positioned such that it is the starting point of the onshore cable pull in route from and will be the subsea cables first point of contact as it is floated to shore.

An excavator with a sheave block shall be in position adjacent to the Bollard Roller to ensure a smooth cable transition from floating to shore/ onshore roller. Divers shall also remove cable buoyancy from the cable prior to the cable reaching the Bollard Roller.

Figure 16: Bollard Roller

4.10 Survey / ROV and Safety Boats

Safety Boats such as the 'Delta 9151' would be used to transfer the pull-in wire from the MLV to shore or from shore to MLV, where applicable.

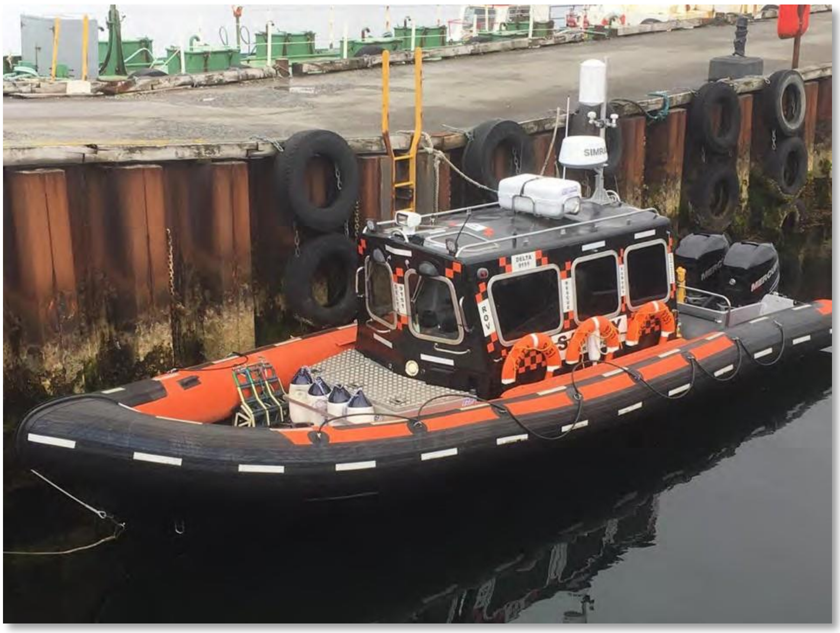


Figure 17: Delta 9151 Safety Boat

ITEM	DESCRIPTION
Type	RHIB
Category	MCA Cat 3 (20 miles)
Dimension – Length (a/o)	9.151m
Dimension – Beam	2.75m
Draft	0.5m
Top Speed	50 knots
PoB (Max.)	2 crew + 6 pax.

Table 8: General Specification of Delta 9151 Safety Boat

4.11 Work Boat – Speedbird One

Work Boat 'Speedbird One' or a similar vessel would be used to perform Safety Boat, Diver and project and cable support works.

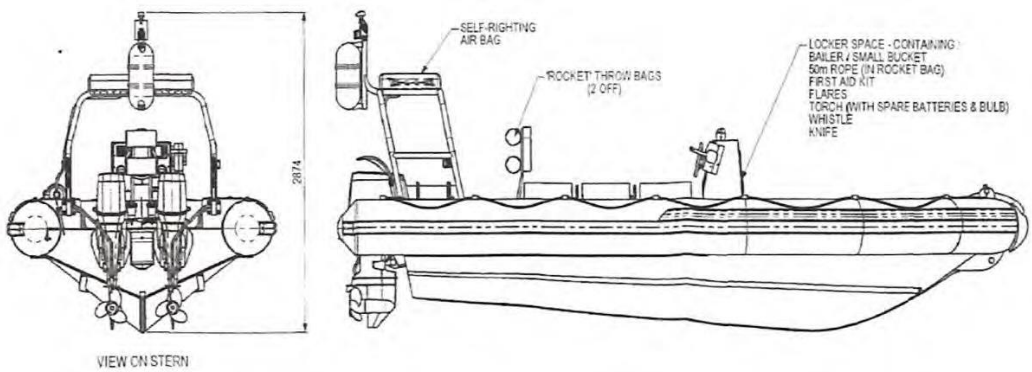


Figure 18: Speedbird One Workboat

ITEM	DESCRIPTION
Type	RHIB
Category	MCA Cat 3 (20 miles)
Dimension – Length (a/o)	8.6m
Dimension – Beam	2.13m
Draft	0.5m
Top Speed	25/30 knots

Table 9: General Specification of Speedbird One Workboat

4.12 Work Boat – UR 101

Work Boat '101' would be used to perform Safety Boat, Diver and project and cable support works.

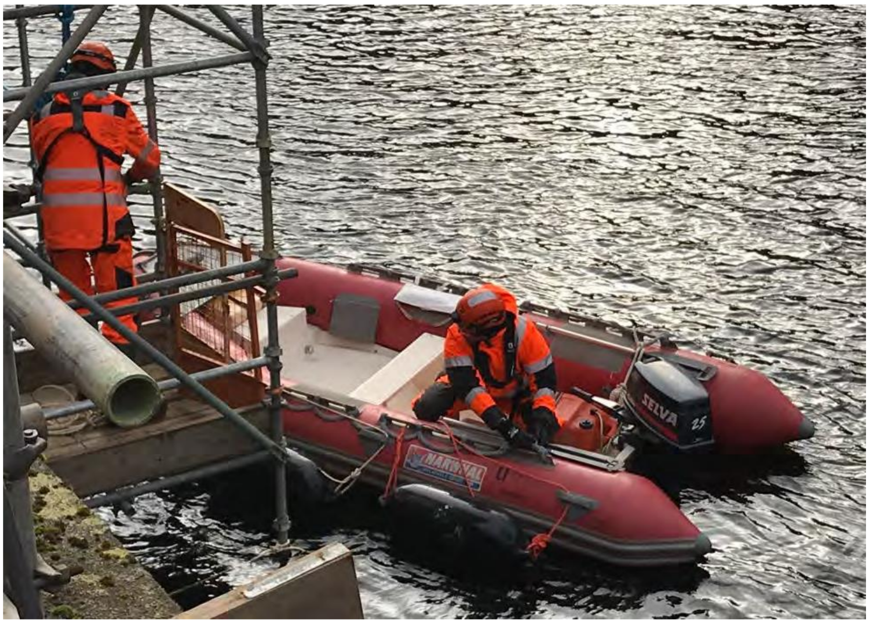


Figure 19: UR 101 Workboat

ITEM	DESCRIPTION
Type	RHIB
Dimension – Length (a/o)	4.0m
Dimension – Beam	1.0m
Draft	0.4m
Weight (Fully Equipped)	0.5te
Top Speed	25 knots

Table 10: General Specification of UR 101 Workboat

4.13 Trenching and Diving Multicat

A Multicat similar to the 'C-Odyssey' below shall be used as the Trenching and Dive Support Vessel for the nearshore cable installation and lowering works. The vessel shall be mobilised with a shallow water trenching tool spread along with a Diving spread.

Figure 20: Example Multicat

ITEM	DESCRIPTION
Type	Multiworker Twenty6
Built	2011
Category	MCA Cat 1 (150 miles)
Dimension – Length (a/o)	26m
Dimension – Beam	10.5m
Draft	2.5m
Free Deck Space	120m2
Passenger	12 (plus crew)
Gross Tonnage	150 GT

Table 11: General Specification of Multicat

4.14 Landing Craft – MV Challenge

A landing craft, like the below example, may be used to transfer plant and equipment from one work location to another.

Figure 21:Landing Craft

ITEM	DESCRIPTION
Type	Landing Craft
Category	MCA Cat 3 (20 miles)
Dimension – Length (a/o)	14.4m
Dimension – Beam	4.26m
Draft	1.44m
Deck Area	10m x 4.2m
Deck Cargo	10te
Passenger	2 (plus 6 crew)
Gross Tonnage	15 GT

Table 12: General Description of Landing Craft

5.0 Cable Protection and Stabilisation Plan

5.1 Overview

Offshore and Onshore surveys have been completed as per Section 2.0. Additional onsite environmental data was also gathered in late Q1 2021 using an Acoustic Doppler Current Profiler (ADCP) system. This, coupled with meto ocean data, allows for a further detailed assessment of the Cable protection methods to be deployed.

A Cable Protection and Stabilisation Plan (CPSP) has been developed as part of the Marine Licence application, see Table 13: Cable Protection and Stabilisation Plan below.

The CPSP conservatively outlines the number of deposits required and is the basis of the assessment made in the Environmental Supporting Information.

Engineering studies are ongoing which may reduce the number of deposits required.

KP From	KP To	Distance (m)	Description	Burial Status	Cable Protection Details
0.000	0.041	0.041	Carradale TJB to HDD Entry Point	Buried	Buried by land-based excavator in field
0.041	0.403	0.362	HDD Duct	Buried	Cable in Drilled Duct
0.403	0.740	0.337	Boulder Field	Buried	Boulder Clearance by Picking & Cable Stabilised by Rock Bags at 85m spacings (3 x 2 off RB/ 3 Mattresses)
0.740	1.157	0.417	Seabed	Buried	Cable buried by Jet Trenching ROV
1.157	1.467	0.310	Steep Sloped Seabed	Surface Laid	Cable Stabilised by Rock Bags at 105m spacings (2 x RB/ 1 Mattress)
1.467	2.692	1.225	Seabed	Buried	Cable buried by Jet Trenching ROV
2.692	2.710	0.018	Rock Outcrop	Surface Laid	
2.710	2.848	0.138	Seabed	Buried	Cable buried by Jet Trenching ROV
2.848	2.885	0.037	Rock Outcrop	Surface Laid	
2.885	3.125	0.240	Seabed	Buried	Cable buried by Jet Trenching ROV
3.125	3.438	0.313	Boulder Field	Surface Laid	Boulder Clearance by Picking & Cable Stabilised by Rock Bags at 105m spacings (2 x 2 off RB/ 2 Mattresses)
3.438	3.619	0.181	Seabed	Buried	Cable buried by Jet Trenching ROV
3.619	3.716	0.097	Steep Sloped Seabed and Boulder Field	Surface Laid	Boulder Clearance by Picking
3.716	3.782	0.066	Seabed	Buried	Cable buried by Jet Trenching ROV
3.782	3.830	0.048	Boulder Field	Surface Laid	Boulder Clearance by Picking
3.830	3.945	0.115	Seabed	Buried	Cable buried by Jet Trenching ROV
3.945	4.063	0.118	Boulder Field	Surface Laid	Boulder Clearance by Picking
4.063	4.157	0.094	Seabed	Buried	Cable buried by Jet Trenching ROV
4.157	4.212	0.055	Boulder Field	Surface Laid	Boulder Clearance by Picking
4.212	4.290	0.078	Seabed	Buried	Cable buried by Jet Trenching ROV
4.290	4.325	0.035	Boulder Field	Surface Laid	Boulder Clearance by Picking
4.325	4.450	0.125	Seabed	Buried	Cable buried by Jet Trenching ROV
4.450	4.636	0.186	Boulder Field	Surface Laid	Boulder Clearance by Picking & Cable Stabilised by Rock Bags at 90m spacings (1 x 2 off RB/ 1 Mattress)
4.636	4.710	0.074	Seabed	Buried	Cable buried by Jet Trenching ROV
4.710	4.970	0.260	Rock Subcrop	Surface Laid	
4.970	5.060	0.090	Seabed	Buried	Cable buried by Jet Trenching ROV
5.060	5.450	0.390	Steep Sloped Seabed and Boulder Field	Surface Laid	Boulder Clearance by Picking & Cable Stabilised by Rock Bags at 85m spacings (4 x 2 off RB/ 4 Mattresses)

5.450	5.766	0.316	Seabed	Buried	Cable buried by Jet Trenching ROV
5.766	6.254	0.488	Boulder Field up to Landing Point (LW)	Surface Laid	Articulated Pipe (488m)
6.254	6.360	0.106	Arran Landing Point to TJB	Buried	Buried by land-based excavator on beach, under road via duct and in field

Table 13: Cable Protection and Stabilisation Plan

	Rock Bags		Articulated Pipe		Grout Bags		Concrete Mattresses	
	22	bags	488	m	20	bags	11	Mattresses
+20% contingency	**27**	**bags**	**586**	**m**	**24**	**bags**	**14**	**Mattresses**

Table 14: Cable Protection Quantity Summary

	Surface Laid (km)	Buried (km)
Length	2.692	3.668
% of Route	42.3	57.7

Table 15: Cable Burial Summary

Maximum Rock Placement Volume (m^3)*	
Rock Placement Volume	25,704
+50% Contingency	38,556

Table 16: Maximum Rock Placement Volume

Note: With respect to rock placement, the berm is based on being required along the length of cable that could be Surface Laid whilst at the same time still being accessible by a Rock Dump Vessel. Additional allowance has also been made to protect the cable in case burial cannot be achieved in certain locations. The resulting length of the route that could result in rock placement is therefore considered to be 3.672km, 58% of the cable route.

A 50% contingency is added to the total rock volume in order to account for any settlement of the rock berm into the seabed during installation.

It should be noted that the above values are considered to be the maximum quantities for the purposes of the Marine Licence application and supporting documents.

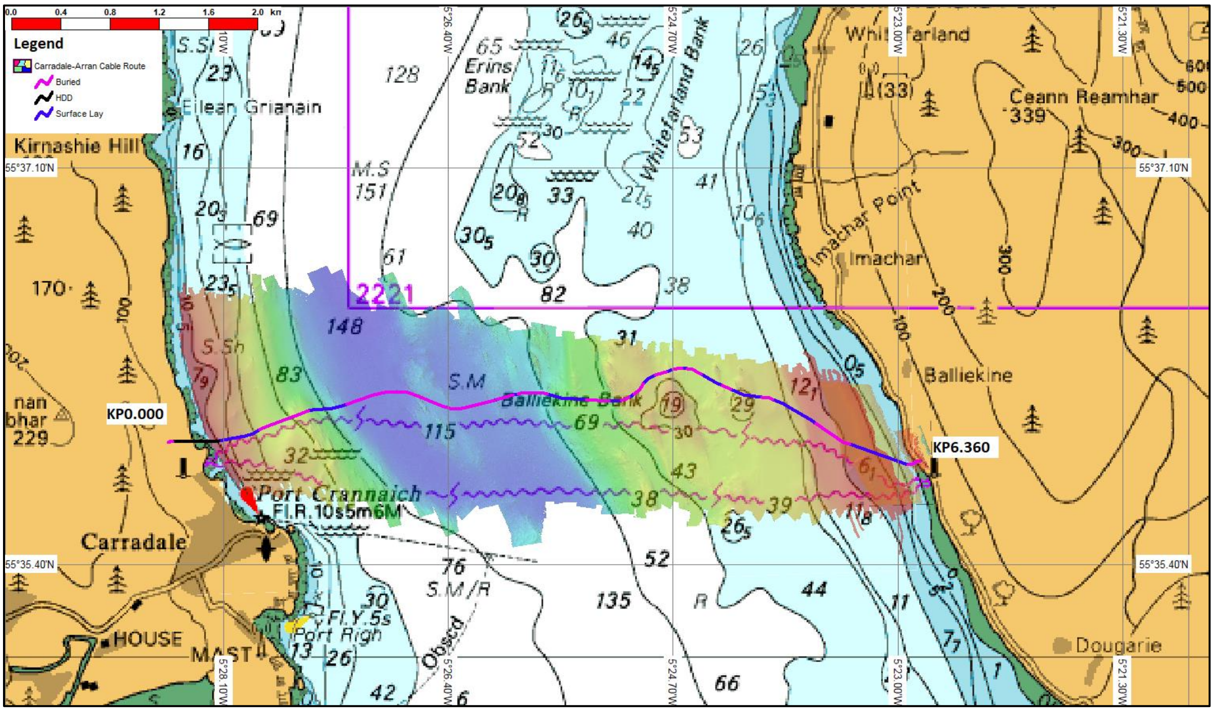


Figure 22: Cable Burial Graphic

5.2 Cable Protection and Stabilisation – Cost Benefit Analysis

Please refer to the supporting Cost Benefit Analysis and summary document.

6.0 Project Description

6.1 Proposed Route

6.1.1 Routing Decision Making Process

Horizontal Directional Drilling was selected for the Landing Point (LP) at Carradale primarily due to the rocky foreshore that would need to be traversed with a conventional shore end. With a direct shore end, the cable could not be buried due to the presence of bedrock and would therefore require additional protection with articulated piping and pinning to the rock face. This would leave the cable exposed to surf zone conditions, presenting an abrasion and suspension risk over time. Additionally, an exposed cable could present additional issues with regards to permitting due to the visual impact of the cable. The only alternative would be to cut through the rock to achieve burial, which may incite further complications regarding the environmental and visual impact of the cable installation.

The LP at Arran was selected primarily for its proximity to the existing substation, which would reduce the terrestrial distance to the termination point. Given that the existing cables also land at the substation, the main concern at the LP was to allow sufficient spacing between the existing and proposed cable, based on the position of the existing cable. The final position of the proposed cable landing will be determined by the nearshore survey results and confirmed location of the existing cable.

6.1.2 Route Description

Route engineering is ongoing and minor alterations to the cable routing shall be made as part of the detailed route engineering.

The Carradale-Arran cable route starts at the Carradale TJP. The HDD duct starts 65m further along the route. After a series of onshore alter courses (A/Cs), it heads offshore at a bearing of 84.432°, and punches out at the ~10m contour at KP0.448. Shortly after the punchout, the cable alters course slightly to the northeast, on a turn with a radius of 200m. The cable continues east, crossing an area designated as boulder field in the Briggs 2018 survey data. The cable proceeds east, as the slope into the channel between the Kintyre Peninsula and Arran begins to steepen by KP1.145.

The cable undergoes two turns with radii of 400m first to the east then northeast, so avoid crossing areas of rock outcropping as evidenced by the survey data. By KP1.500, the cable reaches around 130m water depth, where the slope levels off toward the maximum depth reached by the cable. Across this deep section of the route, burial may be possible due to the absence of rock outcropping and boulders. The cable alters course to the southeast in a turn with a 500m radius, passing through a gap in rock outcropping around KP2.103. The cable renters a more benign part of the seabed after a 300m radius turn to the northeast, where burial may again be achievable. The cable passes across some narrow bands of rock outcrops between KP2.650 and KP2.895, before proceeding east and entering a boulder field area at KP3.170 as it begins climbing up the slope on the east side of the channel.

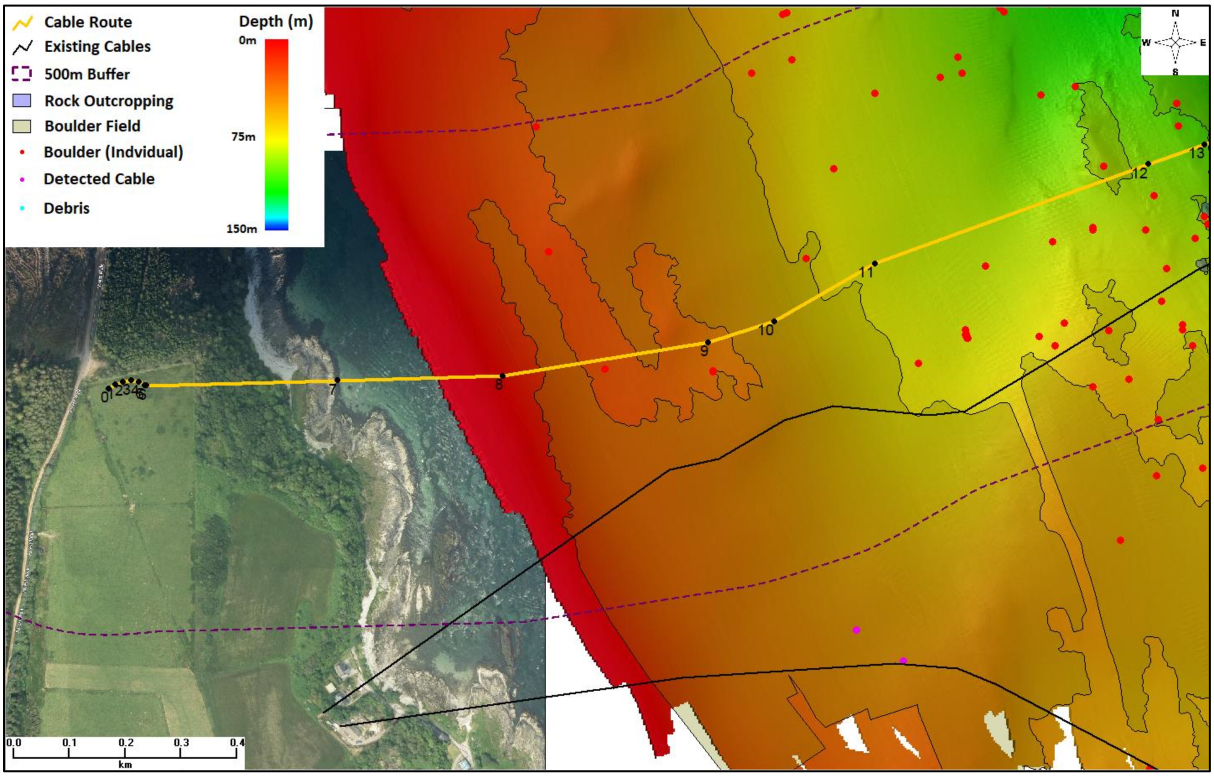


Figure 23: KP0.000 to KP1.000 of the Carradale-Arran cable route, showing MBES bathymetry offshore and satellite imagery at the LP (approximately georeferenced)

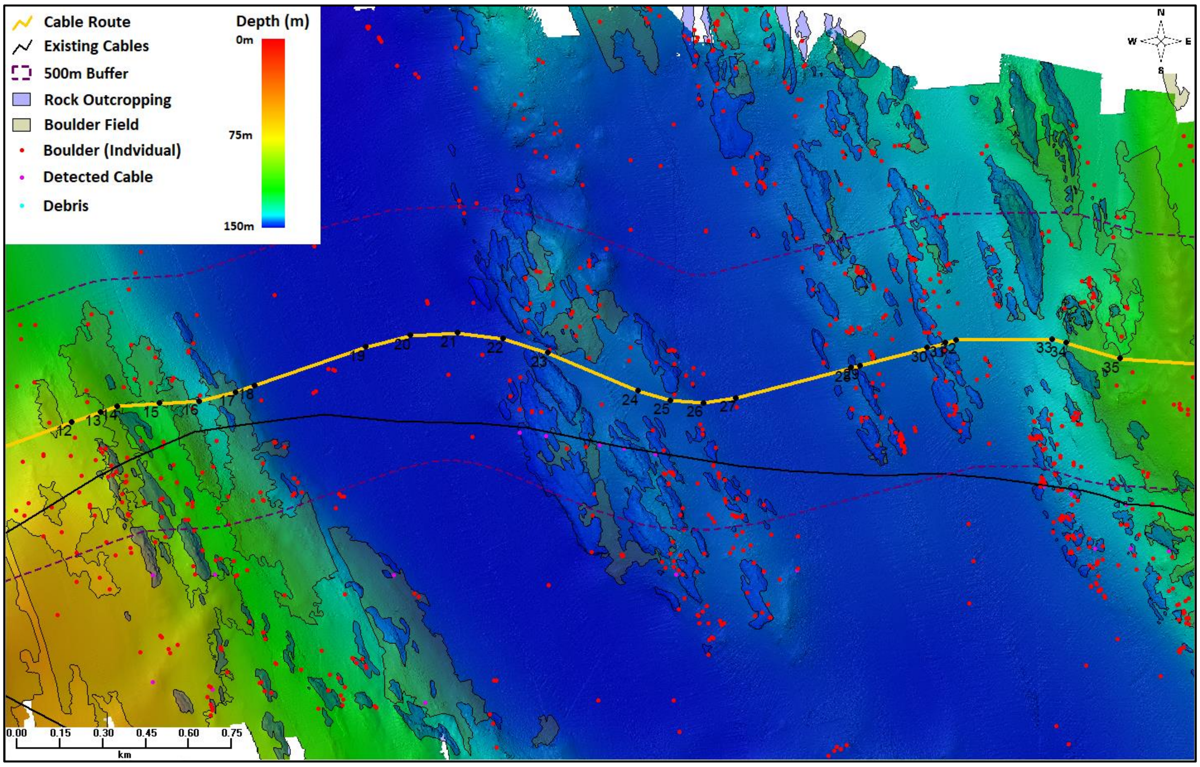


Figure 24: Carradale-Arran cable route between KP1.500 and KP3.100

The cable alters course slightly to a more easterly direction and leaves the boulder field at KP3.470. The slope in this area plateaus and stays at around 71m, before increasing again at KP3.690. From here the slope is steep and characterised by frequent boulder fields, as the cable changes course to the northeast in a curve with a radius of 200m. The alter courses in this area are used to avoid the worst of the boulder fields and Rock outcropping, as well as the shallow Balliekine Bank. Passing north of the bank, the cable continues east, avoiding more rock outcrops with a series of turns, all with a radius of 300m.

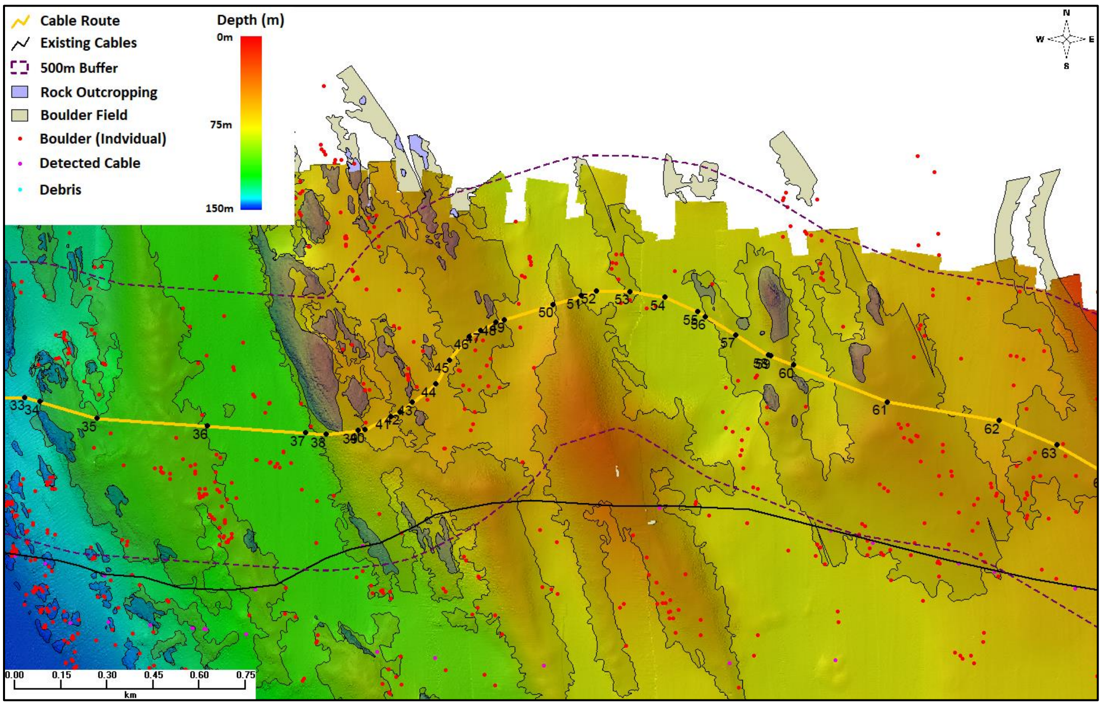


Figure 25: Carradale-Arran cable route between KP3.100 and KP4.850

At KP5.081, the cable alters course to the southeast with a turn 300m in radius, as it approaches the final slope up to Arran. Shortly after starting the turn, the cable re-enters a boulder field, which it continues crossing to KP5.525. Now in shallow water of around 14m, the cable starts its final approach to shore. A final turn with a 400m radius avoids an identified boulder, and lines the cable up for its landing. From the end of the final turn at 12m water depth, the shore end approaches the LP at a bearing of 109.409°. The distance to the LP is 519m. After a series of onshore A/Cs, the cable reaches the TJP next to the existing substation at Arran, located at 55° 35' 49.28"N 005° 22' 48.38"W.

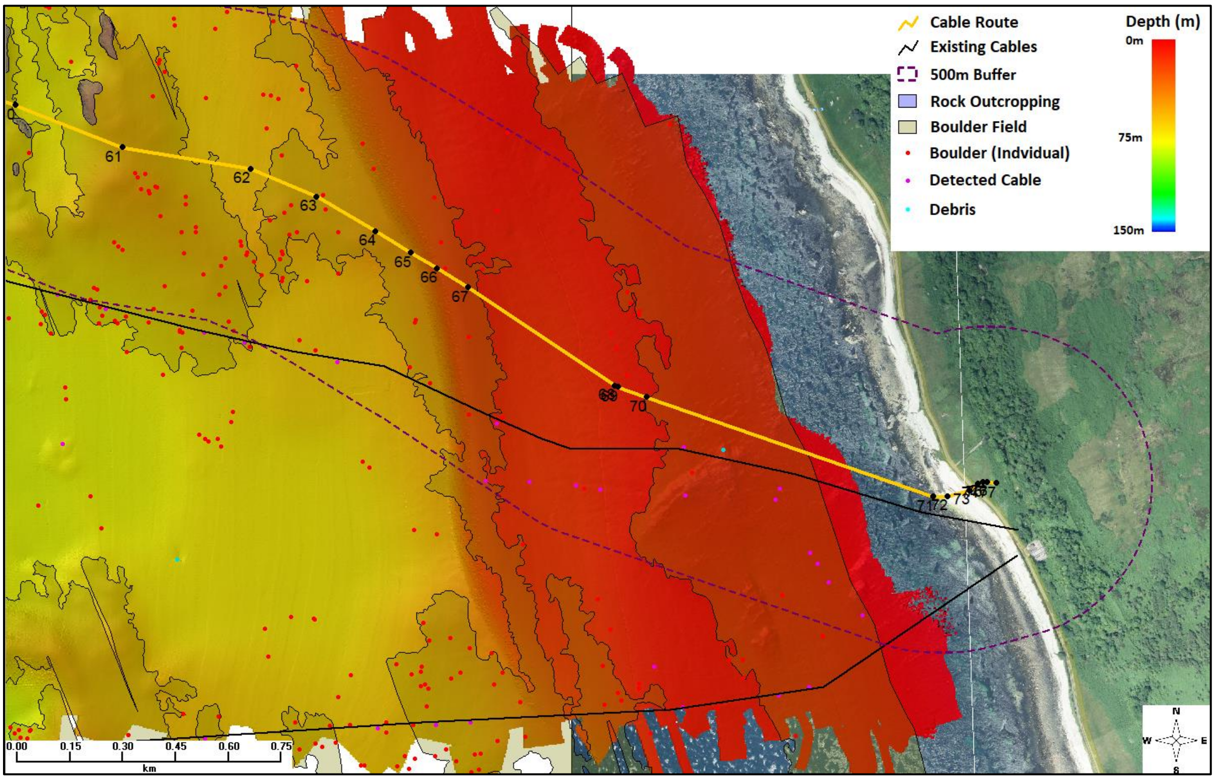


Figure 26: Carradale-Arran cable route between KP4.850 and KP6.255

6.1.3 Route Profile

The below Figure 27 illustrates the route profile for the replacement cable route. The route has a channel that reaches a water depth of c. 150m.

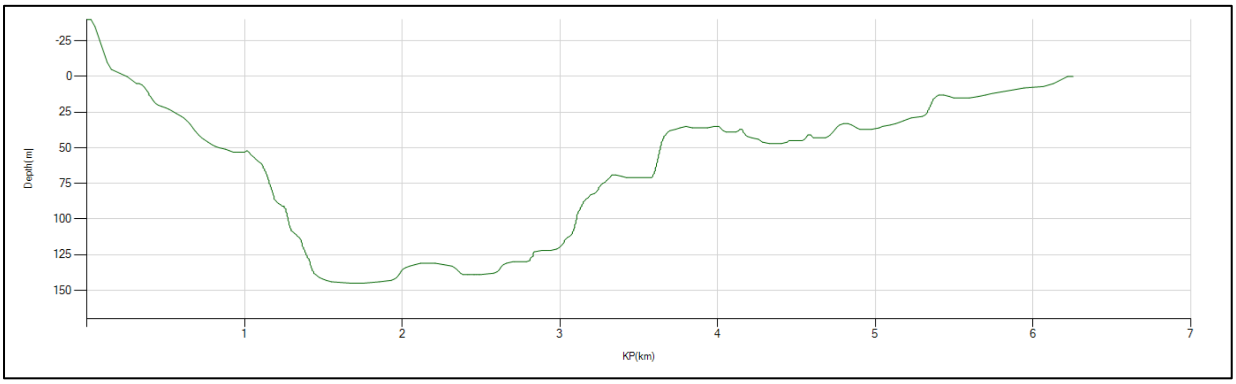


Figure 27: Bathymetry profile along potential cable route Carradale-Arran

6.2 Landfall Preparations

The landfall areas will be prepared with the following tasks undertaken:

- Site setup, including fencing, signage, welfare units etc.;
- Landfall drone survey and site walkover;
- Nearshore visual survey;
- Excavation works along landfall cable route from MLWS to the TJP /HDD Entry (on land) to TJP; and
- Cable pull-in preparation, including cable rollers, quadrants winches etc

6.2.1 Access to Site

Access to the TJP will be via public roads and paths. Where access via public routes are not possible, permissions from landowners have been agreed and will be used throughout the temporary engineering works. All land will be re-instated after completion of the engineering works.

6.2.2 Site Compound

For the onshore engineering works a base will be established which will also act as a local site management office for the works. It shall comprise of, but is not limited to, the following:

- Suitable office accommodation, including space for: site briefing/training, electrical supply internet and telephone connectivity (where applicable and signal is available);
- Lay-down areas designed to take the biggest loads likely to be delivered to site;
- Secure storage areas for all required materials, with segregation of flammable materials;
- Compound lighting where work is required to be undertaken in low light levels;
- An area designated for waste and waste recycling skips, with clear signs to indicate the waste segregation requirements of each container or skip.

The site shall have a traffic management plan in order to maintain safety of traffic entering and exiting the compound. It should be noted that traffic at the local site compounds shall be light and minimal throughout, with the heaviest traffic during set up and tear down of the compound.

The site compound will be secured from the public by means of Heras fencing where applicable and or pedestrian walkways, all relevant site signage and warning signs will be posted where necessary to ensure site safety and public safety.

All responsible methods will be employed to mitigate environmental damage, in particular spill kits (120L bins) and machine nappy pads to catch leaks and drips on site.

The compound shall comply with the environmental requirements for all activities impacting protected or sensitive habitat or species, as detailed in the Construction Environmental Management Plan (CEMP).

120 Liter Spill Kits at each site

Machine Nappies to protect from leaks

Figure 28: 120L Spill Kits and Machine Nappy Trays

6.2.3 Transition Joint Pit (TJP)

The TJP will be the location where the subsea cable is split out into its individual cores and jointed to a land cable.

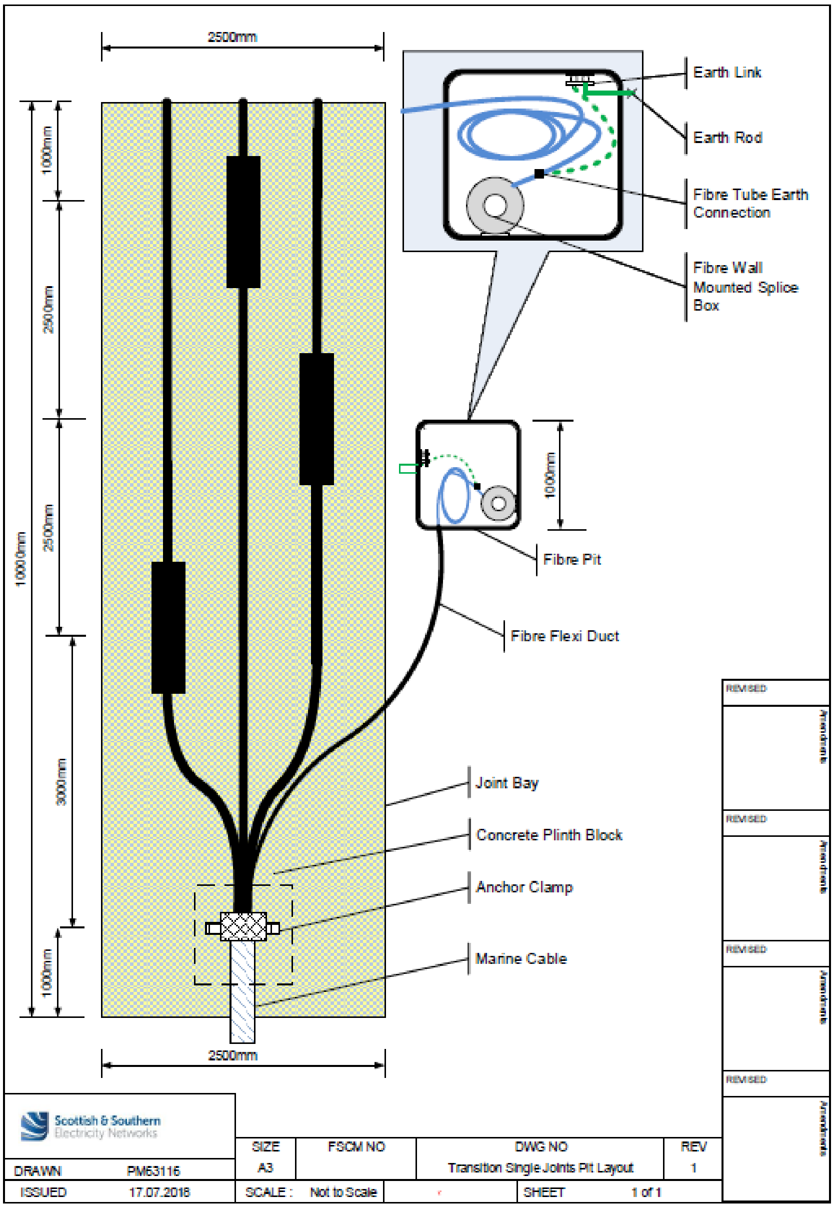


Figure 29: TJP plan

Figure 30: TJP final layout (example)

6.3 Earthing Protection

A Sea Earth may be installed in order to provide protection from surges and lightning strikes to the electrical circuit provided by the newly installed Carradale Arran cable.

A sea earth could be installed at the Arran Landfall. The Sea Earth would consist of up to two bare copper earth wires (c.1kg/m), typically 95mm², installed around the TJB perimeter and connected to the outer marine cable armour wire which has been terminated on the anchor clamp within the TJB. It would also be connected to the metallic elements of the FO cable package within the joint housing.

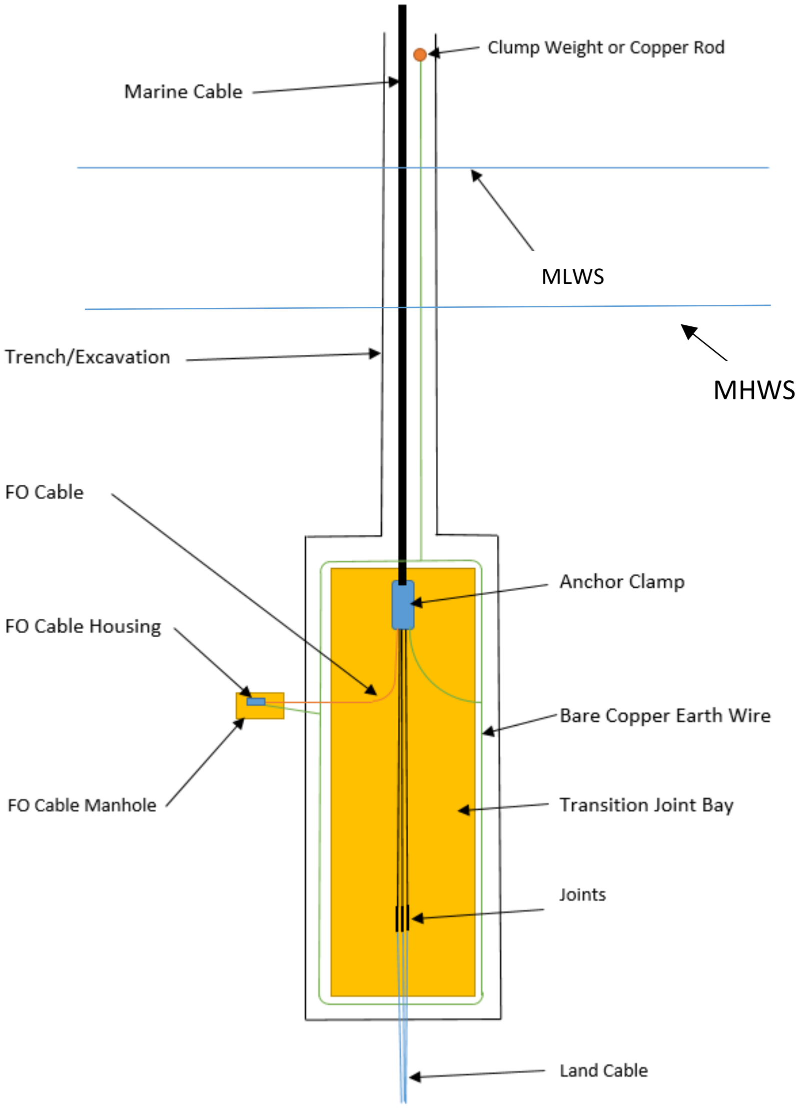


Figure 31: Sea Earth Schematic

The earth wire is typically installed into the same trench as the marine cable (although some cable manufacturers may stipulate a separate trench) with a minimum separation of approx. 200mm. Should a separate trench be required, the trench would remain within the consented +/- 50m cable corridor. The sea earth would be trenched to a maximin depth of approx. 1.5m and a width of approx. 1m. Up to two trenches may be required at Arran, one containing the earth for the submarine cable and one for the fibre optic cable earth.

Figure 32: Bare Earth wire being installed in Subsea cable Trench

The length of the earth wires will vary between sites and the locations of the TJB but will have to be installed 30-50m beyond MLWS or deep enough to ensure the earth wire is always in sea water. At Arran this is anticipated to be approximately 120m per trench from the TJB. Depending on the landfall materials, either a clump weight or a copper rod will have the earth wire connected by either welding or crimping and will then be installed into the seabed below the surface. The copper rod would be approx. 12mm in diameter and up to 5m in length. The rod would be driven into the seabed and covered for protection. Where a copper rod cannot be used as an anchor to the earthing wire, a concrete clump weight with a pre-installed padeye may be used to anchor the earth wire. The concrete clump weight would have a footprint of approx. 1.0m diameter x 0.5m high and would be placed on the seabed.

	Bare Copper Wire		Concrete Clump Weight		Copper Earth Anchor	
Arran ONLY	**120m x 2 = 240m**	**95mm^2 wire @ 1kg/m = 240kg**	**1 per earth = 2**	**Up to 300kg each**	**5m length per earth = 10m**	**15kg / rod = 30kg**

Figure 33: Sea Earth Deposits

6.4 HDD

6.4.1 Landfall Site

The landfall is located just north of Carradale on the Mull of Kintyre. It is noted that there is a Public Right of Way, (PRoW) adjacent to the site which must be protected and kept open for pedestrian traffic.

Figure 34: Landfall site with respect to Carradale identifies the Landfall location and cable route. The new cable route and HDD is identified by the RED line and the YELLOW line in the bottom right corner shows the existing submarine cable which the new cable will replace.

The routing of the HDD is subject to final detailed engineering. The proposed area for HDD seabed punch out is highlighted in grey in the below figure. The two HDD ducts shall run parallel to one another, nominally 10m apart. The proposed area for the HDD Site is shown below in Figure 34: Landfall site with respect to Carradale.

Figure 34: Landfall site with respect to Carradale

Figure 35: HDD drill Location and TJP

6.4.2 HDD Trajectory

The HDD routing is subject to detailed engineering with the proposed drilling trajectory entering the ground on top of the cliff, about +45m from Ordnance Datum, entering the ground at 20° heading in an Easterly direction with a total horizontal length of approx. 436 meters. The bore then exits the seabed at c. -12m OD with an angle of 5°. A marine support contractor will assist the drilling operations as the drilling tools exit the seabed.

To reduce the risk of drilling fluid fracturing to water surface, drilling operations will be executed by using the 'short stop' method. This is where both the pilot and reaming operations are stopped short of the exit point on the seabed. Only in the final stage, once the hole is at the designed diameter, will punch out be made out through the seabed. This will require additional marine support to verify the exit position.

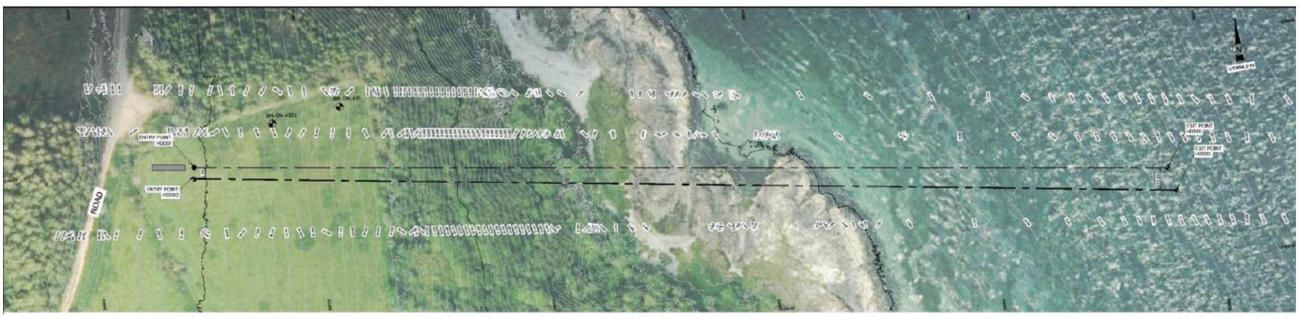


Figure 36: HDD route

6.4.3 Duct Preparations

Based on the requirement that the inside diameter of the HDPE duct should be at least 2.5x the outer cable diameter (132.4mm), the ducts foreseen are as follows:

OD (mm)	SDR Class	ID (mm)	Bore ("/mm)
400	11	327	22 / 559

Table 17: Duct Properties

Verification of the duct diameter and SDR rating will be confirmed during the detailed engineering phase of the works.

6.4.4 Pre-Dredging Pit

Prior to or during drilling operations, a Reception Pit may be excavated in the seabed at the punch out location. The Reception Pit is required to be of sufficient length to permit the laydown of any exposed over-length of the duct, following completion of pigging and end cap fitment works.

The Reception Pit would be up to 270m3 (30m x 3m x 3m) per duct, giving a total potential excavation of 540m3. The pit would be created using an air lift dredging unit or mass flow excavator which can be positioned by either divers or by ROV, with material deposited adjacent to the excavated area.

6.4.5 Duct Delivery / Fabrication Options

There are currently two options which are being considered to install the 400mm HDPE ducts. These are detailed below, with further consideration being given during the detailed engineering phase of the works.

6.4.5.1 Push-In Duct

A pushed duct option installation is accomplished by pushing in of the pre-welded duct from land through the drilled bore onto the seabed.

This would require the duct to be delivered to site in 12m sections with attendant vehicle traffic management. Ducts would then be strung and welded on the track to the NNW of the Drilling Compound, as shown in Figure 37 below. Although this has the advantage of minimising marine support requirements, the disadvantage would be increasing traffic movements to and from the site. The blue line denotes approximate location of duct, strung ready for push in operations. As an alternative the duct may be constructed in the field in proximity to the HDD compound

Figure 37: Push in Operation Duct set up

6.4.5.2 Duct Fabrication onshore and Float-out

With this option the duct would be welded onshore at a suitable launch location for floating the string out. This could be at a fabrication yard on the West Coast of Scotland or with a supplier in Europe. The string would be fabricated in one continuous length, equivalent to that of the HDD bore.

Once constructed, the ducts would be transferred by towing out by sea to the HDD pull-in location and handed over to the installation vessel / barge. The ducts would in turn be prepared for pull-in though the HDD bore, installed and left ready for use.

Figure 38: Floating String approaching pull back

6.4.6 HDD Installation Summary

After mobilisation of the rig to site and installation of the rig, the actual drilling process starts with a piloted bore hole, drilled under steering control from entry (rig side), towards exit without punching out.

Figure 39 Drill pipe with pilot end

After the pilot, the drilling continues with enlarging or reaming, the pilot hole to a size suitable to install the duct for the HVAC cable. One reaming phase per HDD are expected for this work at 24".

Figure 40: Forward reaming hole opener assembly

Upon completion of the reaming phase, which is punched out on to the seabed, the drilling assembly will be retracted to the rig side and replaced with the pull-back assembly. This will then be fed back through the drilled bore and connected to the PE duct positioned on the offshore support vessel.

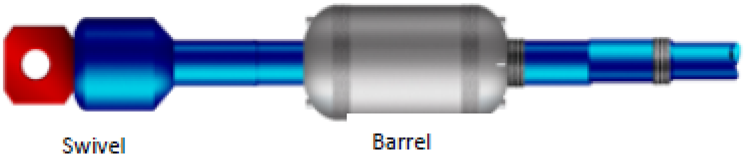


Figure 41: Pull back assembly

The duct is then pulled into the hole (pull-back operation). Once duct is in place and secured, the duct will be calibrated in order to prove that the cable will fit into the duct. A bi-directional (bi-di) pig to 90% of the ID will be pumped through the duct with an aluminium plate in front. If the aluminium plate is intact after passing through the duct, this proves that the roundness of the duct is sufficient for pull in for the cable/FOC.

The pig will also pull a messenger wire through. After calibrating and installing the messenger wire, the duct remains filled with water, the messenger wire (16mm poly-prop rope) is secured and the end sections will be fitted with a temporary cap.

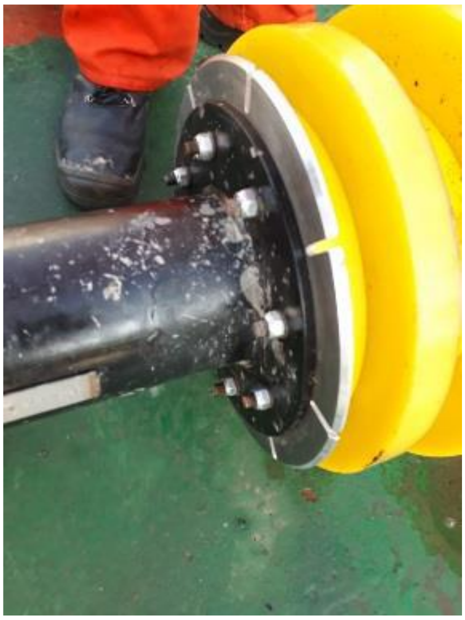


Figure 42: Calibration Plate

The capped duct end shall be laid down in the pre-excavated trench and the end swivel detached by divers. The laid-down duct shall be secured and covered with rock bags or concrete mattresses as required and the site Exit Survey carried out and approved.

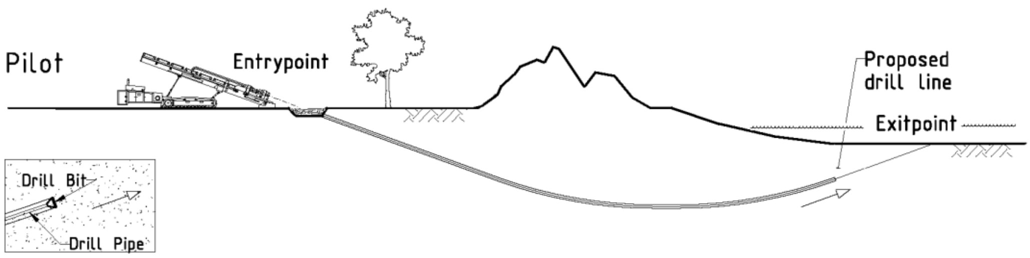


Figure 43: HDD Schematic

6.4.7 Drilling Fluid

The drilling fluid initially foreseen to be used is OCMA, a conventional water / bentonite-based drilling fluid. The drilling fluid is a crucial element to the HDD process and water to create this bentonite mix will be delivered to site by bowsers. The total amount of water required is roughly 3 times the total hole volume drilled.

It is envisaged that arisings from the bore will be primarily in the form of rock chippings. These shall be discharged from the Recycling Unit and hauled away to a licenced disposal point by an approved contractor. Waste Disposal Transfer Notes shall be retained on site.

Surplus material and fluid shall be sampled and tested and disposed of by an approved licenced contractor upon completion of works.

6.5 Proposed Marine Cable Installation Method

This section outlines the envelope of all potential marine cable installation activities for which consent is being requested. Note that the final methodology will be engineered following the results of the pre-installation survey operations and on completion of the On-Bottom Stability (OBS) and Cable Burial Risk Assessment (CBRA). The outline below is intended to give an overview of the options available to the installation of the Marine Cable.

6.5.1 Pre-Lay Debris and OOS Cable Removal

Prior to lay operations commencing, a pre-lay survey will be conducted. The objective of the survey will be to:

- Identify and investigate possible debris;
- Identify any obstructions on the proposed route

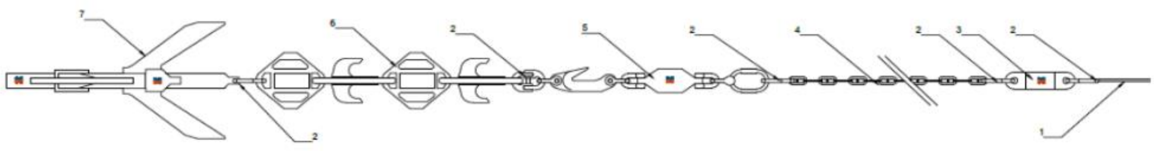
Any obstructions or debris will be removed, if possible. A work class ROV or Pre-Lay Grapnel Run (PLGR) will be undertaken to remove debris from the proposed route. In the nearshore area, a diver may be required to remove debris. It is envisaged that natural debris found to obstruct the cable replacement operations will be moved away from the RPL by 20-30m. Any manmade debris will be removed from site and disposed of appropriately.

If debris or an obstruction cannot be removed from the planned route, the offshore surveyors will micro-route around the debris/obstruction in consultation with the on-board Client Representative (CR) – at all times staying within the licensed installation corridor.

6.5.2 Pre-Lay Grapnel Run (PLGR)

A PLGR may be required to prepare the route for burial where deemed appropriate. A typical grapnel train is shown below in Figure 44: Typical Grapnel Train. Multiple pre-lay grapnel runs both end to end and perpendicular to the route may be required within the licensed installation corridor as part of pre-burial activity, where appropriate.

Please note that a PLGR run may only be conducted in areas where burial of the cable is expected.



	ITEM	QUANTITY	SWL	WEIGHT
1	VESSEL WINCH WIRE 48mm x 1000m	1	200TE	-
2	HAMMER LOCK	5	26TE	6Kg
3	BEARING SWIVEL	1	25TE	59Kg
4	Ø32MM CHAIN	Approx 7m	+25TE	-
5	GIFFORD TYPE HOOKS	1	13TE	240.4Kg
6	RENNIE TYPE HOOKS	1	13TE	237.2Kg
7	SLIDING PRONG GRAPNEL	1	13TE	223Kg

Figure 44: Typical Grapnel Train

6.5.3 First End Pull-In

Onshore preparation for the TJP and pull-in site shall be completed ahead of the CLV arriving to location, this will include quadrants, rollers cable handling equipment and personnel. Equipment shall be accurately orientated and positioned via the use of handheld DGPS positioning devices. Included in these operations, and ahead of the CLV arrival, will be the preparation of the HDD messenger wire. Firstly, ensuring that the onshore winch wire is connected to the onshore end of the HDD duct messenger line, divers shall remove the end cap of the HDD and extract the messenger line out of the duct. The messenger line will be pulled away from the duct entrance and left in position on the seabed with a clump weight attached. The position will be noted and shared with the CLV.

The CLV will then arrive at location with stern to the shore. The ROV will be deployed, along with a recovery winch wire. The ROV will connect the recovery winch wire to the HDD messenger line and move clear of the wires to monitor. The recovery winch will then recover the messenger line to the CLV deck whist the onshore team pay out on the main pull-in winch operating as a slave to the CLV messenger line recovery. Once the winch wire in on the deck of the CLV the messenger line is to be removed from the system and the winch wire connected to the cable pulling head with a suitably rated swivel between them. The onshore team will then be asked to take up any remaining slack in the system by picking up on the main pull-in winch.

All parties involved in the operation will be advised of the intention to commence the pull-in and confirm their readiness to commence. The CLV shall be master throughout the operations with the onshore team acting as slave.

The Pull-in operations continues with the ROV deployed subsea monitoring the cable catenary and the entry into the HDD bell mouth.

Figure 45: Cable entry to HDD Bellmouth

Figure 46: Carradale 1st End Pull-In Overview

An excavator will be used at the TJP location to support the cable end into any quadrant handling equipment at TJP entry as required. The cable end will be visually monitored throughout the pull-in operations as it reaches the TJP and beyond. The cable will be pulled passed the TJP to an agreed point approximately 20m beyond the TJP. The cable tension will then be relaxed and secured into the TJP to avoid any uncontrolled cable movements.

6.5.4 Cable Lay Operations

Once the cable is successfully pulled to its required position onshore, the CLV will commence laying the cable on the seabed from the First end to the Second end. The CLV will be a DP2 Class vessel and expected cable laying speed will be between 200 m/h and 450 m/h.

During cable lay operations, the vessel crew will monitor the lay to ensure the cable is laid within the consented installation corridor and that the mechanical parameters of the cable are adhered to; expected lay tensions are between 10 kN and 20 kN.

Monitoring of the cable's touchdown point on the seabed, which is expected to be between 1 x water depth (WD) and 1.5 x WD away from the installation vessel, will be conducted with the vessel's ROV and/or subsea sonar equipment.

During cable lay operations, the vessel will install the cable within the cable installation corridor. During these operations, the vessel structure may be outside the licenced corridor however all deposits will be installed within the allocated boundary. Vessel movements will be notified by notice to mariners issued to inform other sea users for safety.

6.5.5 Second End Pull-In

The site for the 2nd end pull-in will be prepared ahead of the arrival of the CLV to that location. This will require there to be separate pull-in equipment sets for each landfall site to avoid any delays due to repositioning them for the CLV when arriving on site from the cable lay works.

Once the cable has been installed along the main RPL towards 2nd end, the CLV will stand off at a suitable position offshore and hold position at the agreed WD. The cable support vessels will then approach and assist with the cable offload into an omega shape and act as a Hold Back support vessel in order to manage the cable at this location as the omega is laid on the water surface. Cable floats will be attached to the cable by the CLV deck crew and lowered into the water column and the omega loop laid.

Figure 47: Typical Pull In Floats

As the omega is created, the bight shall be managed by the support vessels. A support vessel shall also transfer a messenger line from the CLV to the onshore main winch wire and connect at the Hand Over Zone in the same manner as performed for the 1st end. The CLV shall pick up on its messenger line and receive the onshore winch wire on board. The main winch wire will be connected to the cable pull-in head via a suitably rated swivel and prepared for pull in.

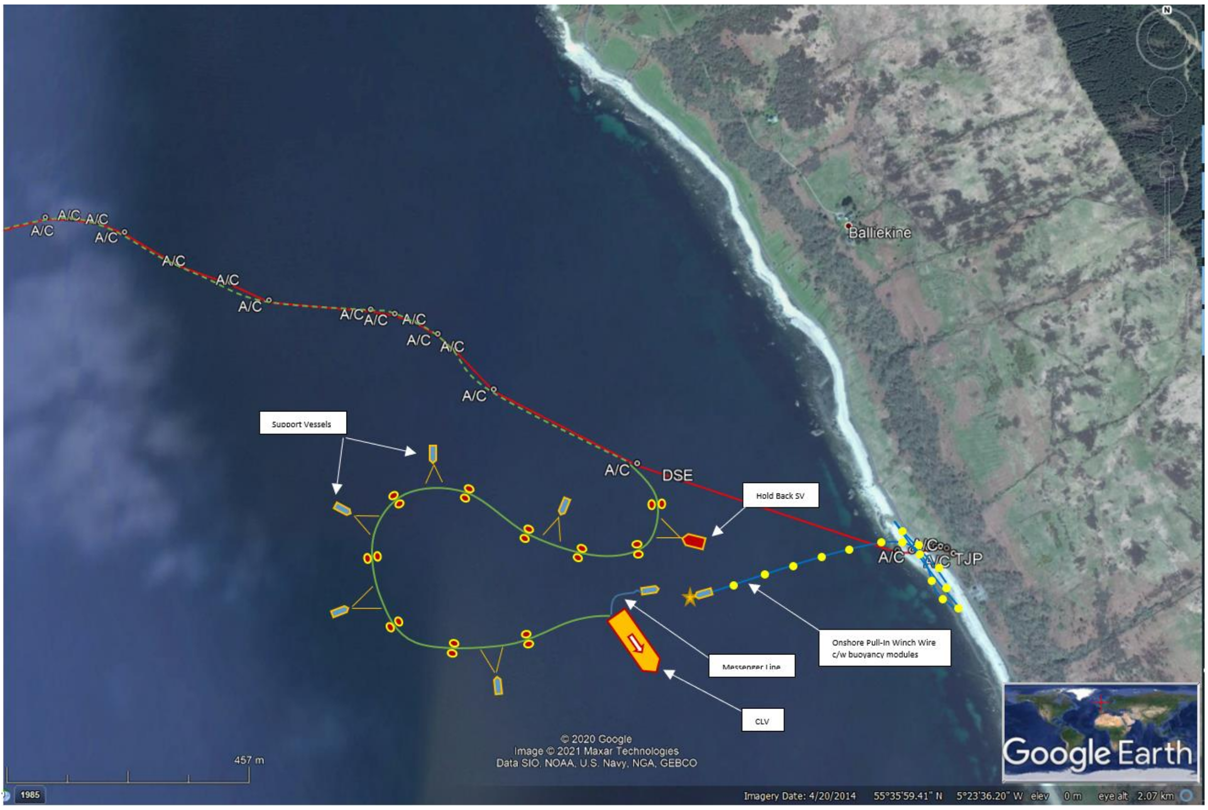


Figure 48: Arran 2nd End Pull In Overview (example)

The cable will be received by support craft that will manage the cable bight on the surface of the water ensuring the minimum bend radius (MBR) of the cable is not compromised. The CLV crane may be used to support the offloading of the cable end form the CLV. Pillow floats will be installed along the length of the cable to prevent the cable from sinking and therefore reducing the pull in tension. This will also make it easier for the support vessels to manage the omega bight on the surface. The pace of operations shall be dictated by the crew on the CLV managing the speeds on the lay-system but the positioning and the control of the cable bight and support vessel shall be managed by the Beach Master ensuring that the cable MBR is not compromised.

It should be noted that that the cable pull-in at the Arran location will take place close to an in-service 11kV subsea cable. The newly installed cable will be positioned a safe distance from the existing cable in line with SHEPD requirements.

Figure 49: Arran 2nd End Pull In Overview (example)

Once the full length of cable has been laid out on the water surface, the CLV will relocate to a safe distance from the omega bight and support vessels. Under direction from the Beach Master, the pull in shall take place with support vessels assisting the cable pull in works. The pull-in shall continue until the cable end is received onshore. The support vessels and divers will manage the floating cable and excavators may be used on the beach to support the cable end. The pull in shall be complete when the agreed overpull from the TJP has been achieved.

Once the final pull in has been achieved the cable floats will be released in a systematic way (offshore to nearshore) and the cable settled onto the RPL. Offshore survey will take place at MHWS and the onshore survey at MLWS using a handheld DGPS. This will create an overlap in data to stitch together.

Figure 50: Second End Pull In Example

6.5.6 Cable Protection Methods

This section outlines the envelope of all potential marine cable stabilisation and protection methods for which consent is being sought.

6.5.6.1 Mattress Installation

If shallow water mattress installation is required, a Multicat type vessel will carry out the installation in shallow water. During the installation in shallow water, the Mulitcat may need to hold position by means of clump weights. An overview of the likely clump weight and mooring arrangement is shown in Figure 52: Example Clump Weight Configuration, note that the clump weights are designed to be non-penetrative and rely on the self-weight of the arrangement to provide stability to the vessel.

Figure 51: Concrete Mattress Deployment

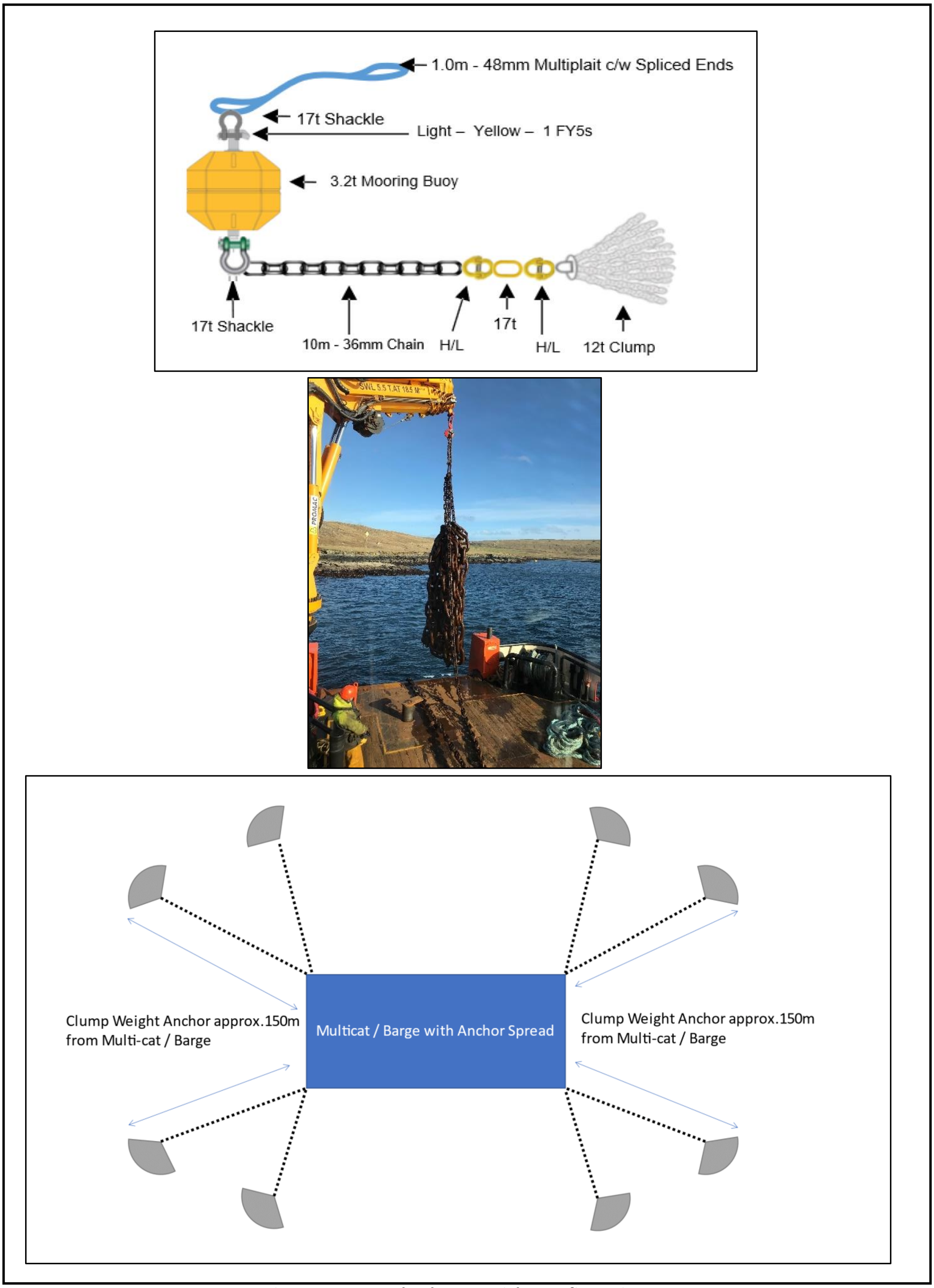


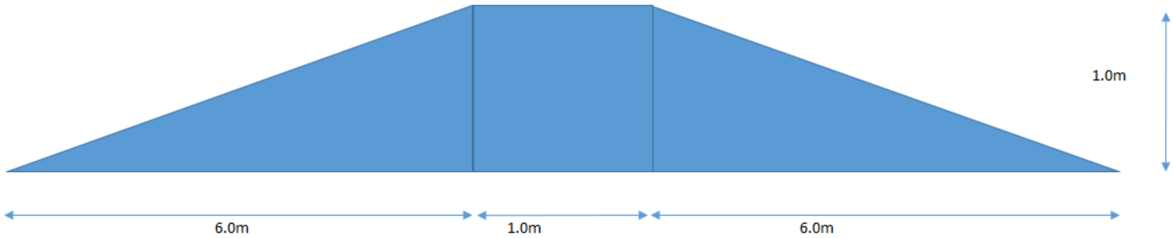
Figure 52: Example Clump Weight Configuration

6.5.6.2 Rock Placement

The cable protection strategy may include a rock placement campaign to provide stability and protection in areas where burial may not be achievable due to localised geology.

Should this be required, then the volume of rock, identified in Section 5.0, Table 16: Maximum Rock Placement Volume, has been calculated based on a typical conservative Rock Berm design.

The conservative rock dump design profile is a 13.0m widespread (6.5m either side of the cable centreline) with a minimum 1.0m depth of cover at the centreline, tapering to each side with a 1:6 slope. Volume is approximately 7.0m^3 of rock per metre of cable.



Total Volume = 7.0m^3/m

Figure 53: Typical Rock Berm Design

Final Rock Berm Design will be agreed with a specialist contractor and in line with Cable Burial Risk Assessment (CBRA).

6.5.6.3 Rock Bag Installation

The cable protection strategy may include the installation of Rock Bags onto the cable to provide stability. The Rock Bags will be stored on the vessel and lifted into position using the vessel's crane (see Figure 54 and Figure 55). The vessel's ROV monitors the installation and detaches the crane wire from the Rock Bag once in position.

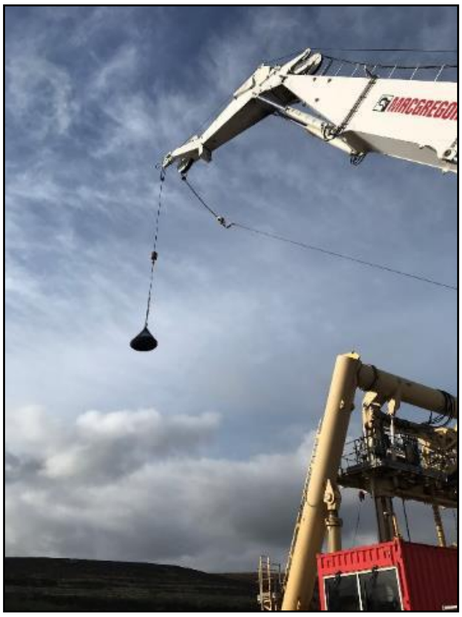


Figure 54: Rock Bag Being Lifted off the Vessel

Figure 55: Rock Bag in Position Subsea

Details of a 4te rock back can be seen in Table 18: Rock Bag Dimensions below:

Rock Bag Mass in Air (Te)	Diameter (m)	Height (m)	Volume (m³)
4	2.4	0.6	2.5

Table 18: Rock Bag Dimensions

Where practicable, the Rock Bags will be filled with stone local to the installation site.

The Rock Bags may be installed as soon as the cable is laid by a separate vessel to the cable lay vessel. Simultaneous Operations (SIMOPS) between the two vessels will be managed in the planning phase as well as the offshore phase via implementation of a SIMOPS plan. Each vessel will be named in the Notice to Mariners (NtM) as required in the supporting Fisheries Liaison Mitigation Action Plan (FLMAP).

6.5.6.4 Grout Bag Installation

There are currently no pre-installation plans for grout bags to be used, however they may be required to rectify any cable free spans that are observed following cable installation. If these are required, then this can be installed from the CLV using its 150te subsea crane in a similar manner to the Rock bags as described in Section 6.5.6.3 above. Each 1 Te Grout Bag (0.9 m x 0.9 m x 0.9 m) contains 40 x 25 kg individual units. If required divers will position the individual bags where free span rectification is required.

6.5.6.5 Post Lay Burial

It is proposed to utilise Q1400 jet trencher based on Global Symphony for all post-lay burial operations.

Figure 56: Q1400 Trencher

Sequence for Cable Burial Operations (Jetting Mode):

1) Post-lay data processed and uploaded to navigation screen (carried out on the CLV) for the Trencher Pilot, pre-trench report also conducted and discussed.
2) Launch trencher at start of burial location.

3) Deploy Jet-legs and transition in to required burial depth over 10m transition
4) Continue trenching operations tracking cable using TSS440.
5) Transition out over 10m at end of trench and recover to deck.

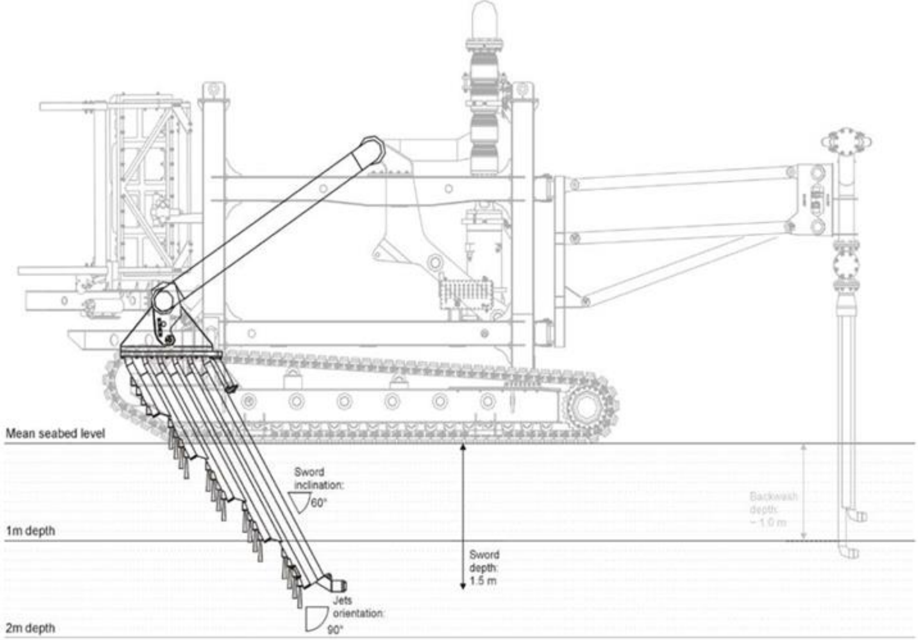


Figure 57 Example set-up of Q1400 with 2m swords deployed at 1.5m for a DOL of 1.0m. Backwash deployment is represented in light grey colour

6.5.6.6 Split Pipe / Uraduct Installation

The cable protection strategy may include the installation of Split Pipe or Uraduct, generally this is installed following the cable pull-in operations by divers and protects the cable in the nearshore and intertidal section of the cable route. Divers will not be required for installation in the intertidal section.

See Section 5.1 for details of anticipated Split Pipe or Uraduct installation. An example Split Pipe installation is shown in Figure 58: Example Split Pipe Installation. In locations where Split Pipe is to be employed as cable protection, this will be installed onto the cable from the CLV and deployed over the cable chute as part of the cable lay.

Figure 58: Example Split Pipe Installation

6.6 As-Built Survey and Site Re-Instatement

Following completion of operations, an As-Built survey will be undertaken of the replacement cable and protection. This will record the as installed position of the cable and the deposits utilised to stabilise and or protect the cable. The landfall sites will also be re-instated as agreed with landowners.

The replacement cable will subsequently be electrically jointed to the land infrastructure. The routing and installation of the land infrastructure is not covered as part of this Project Description which supports the marine licence application.

The As-Built survey will document the installed position of the cable from TJP to TJP with events listed and positions given (i.e. Rock Bags, Mattresses, and Split Pipe etc.).